

Space Shuttle Program-Tin Whisker Mitigation

Labor Hour Rough Order of Magnitude
(ROM) Estimate

Resources:

NASA Orbiter Avionics and Electrical Systems, Orbiter Sustaining Engineering Office

USA Space Systems Engineering, GN&C Hardware Subsystem Area Manager

<http://nepp.nasa.gov/whisker>

"Space Shuttle Program-Tin Whisker Mitigation", K. Nishimi, Intl. Symposium on Tin Whiskers, Apr. 2007

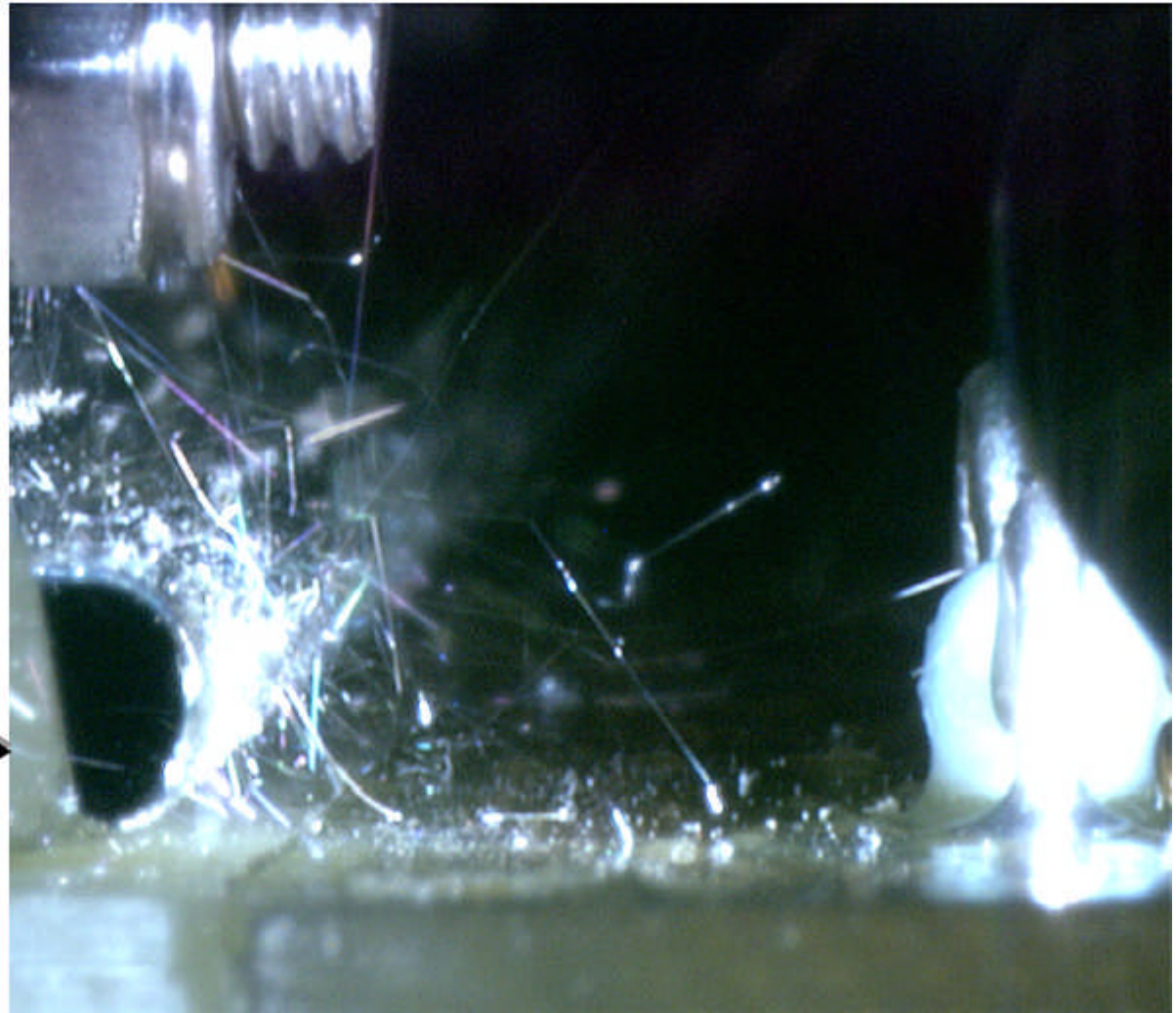
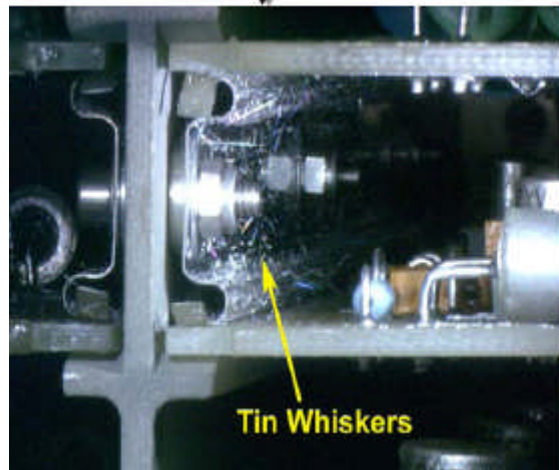
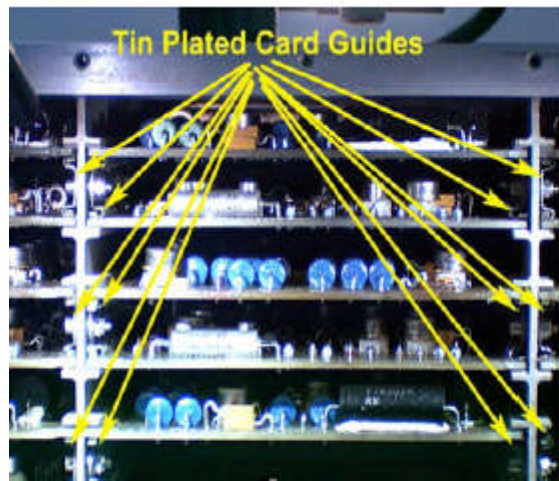
NASA Shuttle Logistics Depot - Tin Whisker Video

Background

"Space Shuttle Program-Tin Whisker Mitigation", K. Nishimi, Intl. Symposium on Tin Whiskers, Apr. 2007

- In March 2006, a Flight Control System (FCS) avionics box failed during vehicle testing, and was routed to the NASA Shuttle Logistics Depot for testing and disassembly
- Internal inspection of the box revealed tin whisker growth visible without magnification
- Space Shuttle Program implemented tin whisker remediation strategy following discovery of tin whiskers in Orbiter hardware
- Complex investigation and planning involved cooperation among many disciplines and geographical locations
- Whiskers grew from pure tin plated circuit card retainers, not from electrical components
 - Intent of tin plating in original design was for corrosion protection of Beryllium-Copper (BeCu) retainers

Flight Control System (FCS) avionics box with cover removed



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Background Continued

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- NASA formed multi-disciplinary Tiger Team to investigate extent of findings and develop recommendations
 1. Detailed investigation of Flight Controls hardware from same vendor (12 per vehicle)
 2. Broad investigation of 100+ other high-criticality Orbiter hardware
- Functional diversity: design engineering, logistics, test engineering, materials & processes (M&P), ground operations, research
- Geographical and corporate diversity: multiple NASA centers (JSC/KSC/GSFC), prime and major subcontractor sites, hardware vendor and supplier

- Flight Control System (FCS) avionics boxes:
 - 52 total quantity across fleet = 12 per vehicle plus spares
 - All from same manufacturer, using same card retainer design
- Sampled 15 of the 52 boxes across four different types
- Tin whiskers only growing from card retainers; up to 18 mm
- Some loose tin whiskers present
- Newer built boxes (~1989) from Endeavour's initial assembly generally contain longer and more dense tin whisker growth
- One box found to have no tin plating on card guides

Flight Control System Remediation Plan

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- Avionics Lab: Remove tin plating and tin whiskers
 - Expedite procurement of non-plated card retainer assemblies from vendor
 - Cycle boxes through lab
 - Incoming testing, disassembly / card removal
 - Assess gross order-of-magnitude quantity of loose whiskers
 - Clean chassis and circuit cards
 - Cards pass magnified inspection
 - Conformal coating touch-up via brush coatings as needed
 - Reassemble with non-plated card retainers
 - Full acceptance testing at box level: vibration, thermal, functional

FCS Tin Whisker Mitigation Effort ROM Estimate	
NASA	720
Contractor Operations, Scheduling & Project Management	2550
Contractor Logistics	660
Contractor Technicians	7800
Contractor Quality & Safety	869
Contractor Engineering	4200
ROM Total Labor Hours	16799